Nordisk Industrifond
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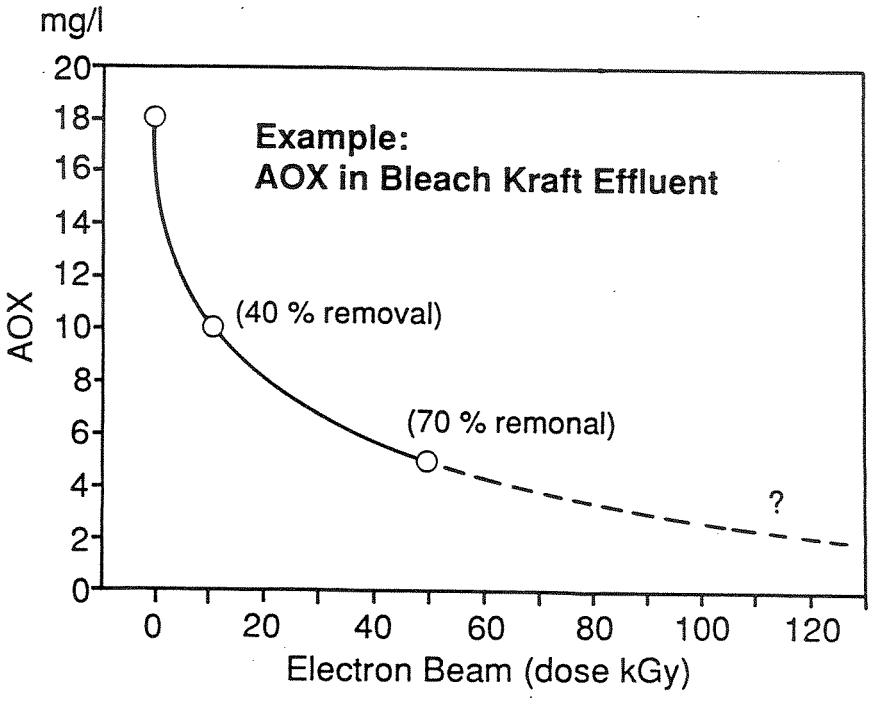
SCANDITRONIX

Half Way Interim Report

O-91022

RADIOBIO

Degradation of recalcitrant chlorinated organics by combination of radiochemical and biochemical oxydation



Norwegian Institute for Water Research NIVA

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Abstract:

The method have been tested for degrading chlororganics (AOX) in kraft bleach effluents with a removal efficiency of aproximately 75%. With optimization, a theoretical outline indicates that it should be possible to remove 90% AOX with a capacity of 9-10 cubic meter per hour. Medium doses of electron beams enhanced the biodegradability, whereas large doses impeded the biodegradation. No toxicity was observed after electron beam treatment. The method was also tested for degrading fullchlorinated benzenes from magnesium factory effluent, but with only minor efficiency. The work in the next phase will focus on treatment of AOX in concentrates (sludge and membrane filtrate) from kraft bleach effluents.

4 keywords, Norwegian

1. Organokloriner
2. Blekeriavløp
3. Elektronbehandling + biol. nedbrytning
4. Renseteknologi

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1. Organochlorines
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3. Electron beam treatment + biol. treatment
4. Waste water treatment technology

Project leader

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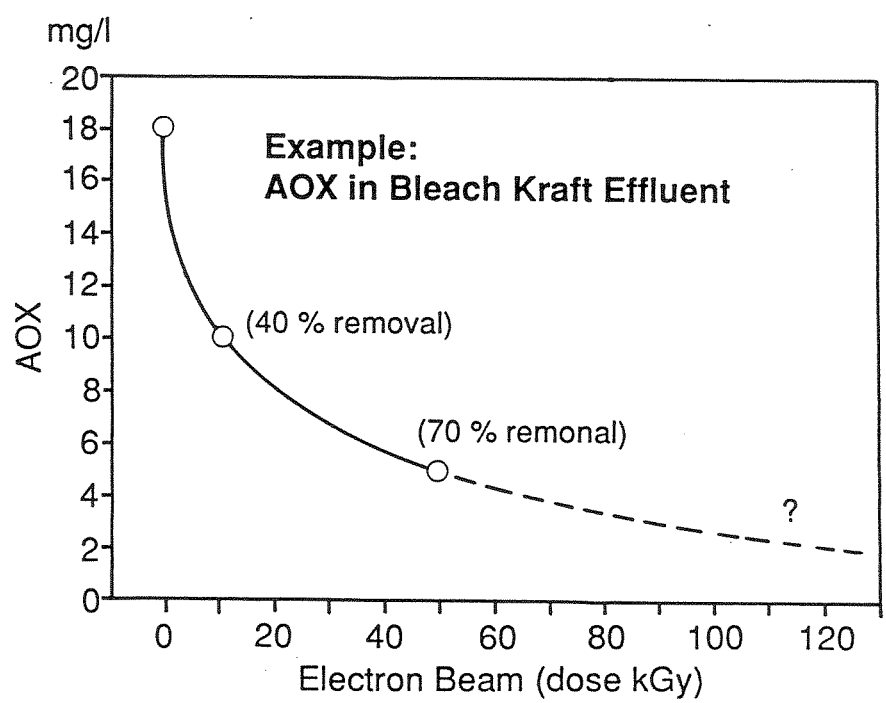

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Half Way Interim Report

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RADIOBIO

Degradation of recalcitrant chlorinated organics by combination of radiochemical and biochemical oxydation

Oslo 31/8-92

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INTRODUCTION

High-energy radiation interact with water (indirect radiolysis) and the waste compounds itself (direct radiolysis) producing ions, free radicals and other highly reactive, shortlived compounds. These active species mediate chemical and biological changes in the waste that can be utilized in a great variety of purification processes. Radical formation within the waste products itself (direct radiolysis) is normally of less importance than the formation that takes place by splitting the water molecule (indirect radiolysis) in most waste waters (Butler et al 1984). It is first of all with this respect that radiolysis proves superior to photolysis. UV light is only capable of generating radicals in organic pollutants that absorb light, eg. PAH, humic matter etc., but has not enough energy to split the water molecule into free radicals. In addition, accelerated electrons (or electron beams, EB) penetrate particulate pollutants, attacking them from inside, and is as effective in turbid effluents and sludges, as in clear water solutions.

EB is ideally suited to treating low-level, but still dangerous, concentrations of organic contaminants and microbes as it makes the water itself reactive for some picoseconds, i.e. during the irradiation. For example, a drum of waste solvents may be burned, distilled, pyrolyzed, or dumped at approved sites. However, the same volume of solvent dispersed in 50000 liters of water, is a disposal nightmare.

Removal efficiencies is greater than 99.9% for some compounds, and reaches that limit for several others, while other compounds are more recalcitrant, as e.g. the full chlorinated benzenes.

Accelerated electrons are more effective than gamma rays in producing radicals mostly because the flux of fast electrons can be generated much higher than the scattered electrons along the gamma spurs. Gamma, however, can penetrate much thicker materials, often several feet, whereas electrons in practicle terms only can penetrate 3.5 cm. One problem encountered by using gamma is that it includes a radioactive source, which constrains its applicability both from a public opinion point of view and strickt regulations by authorities, as well as the problems with spreading of radioactive sources and the disposal of old "too-low activity" sources. An accelerator, on the other hand, can be turned on and off. As long as the energy is below 10 MeV, no radioactivity is induced.

The most important reactive species that are generated by EB is, the hydroxyl radical (.OH), free solvated electrons(e^-_{aq}), hydrogenradicals (.H), hydrogenperoxide, and hydrogen. The hydroxyl radical is the strongest oxidant known with a reaction constant of about 10^{10} M^{-1} s^{-1}. It is first of all the oxidative power of these radicals that makes radiation interesting in purification of effluents. Hydrogen peroxide is formed by reaction between two hydroxyl radicals. This is also a strong oxidant.

The free solvated electrons are strong reducing agents. They have an odour removing effect through neutralization of charge, as well as being fairly effective in dehalogenation (JAERI 1988, Singh et al 1986). The hydrogen radical performs mainly decolorization, and contributes little to oxidation. The reducing effect of the free solvated electrons are considerably reduced if oxygen is present as the following reaction takes place:

$$e^-_{aq} + O_2 \rightarrow O_2^-$$

Moreover, EB proves very effective in disinfection, it penetrates effectively resting eggs and spores.

In principle, all organic materials can be degraded by EB, if the radiation dose is large enough (Singh et al 1986, JAERI 1988). However, as an accelerator requires energy, total oxidation of organic material by radiation is often not the most ecconomic way to go. Several combined treatments are tested over the last years (Futuretech 1990, JAERI 1988), e.g. EB plus ozone, EB plus hydrogen peroxide, EB under nitrogen atmosphere, etc. Of particular interest is EB as a pretreatment to biological treatment as it is often shown that the biodegradability of several compounds are considerably enhanced in this way. For example, Japan Atomic Energy Research Institute (JAERI) has shown that composting rate of municipal sewage sludge can be increased 8 fold by a small dose of EB (2-3 kGy). The same is shown to apply for several organic micropollutants (JAERI 1988, Futuretech 1990).

This was the idea behind the RadiBio-project application to Nordisk Industrifond where the main aim was to try this combination to remove chloro-organics (AOX) from kraft bleach effluents, also with some experiments performed on other industrial effeluents.

SHORT DESCRIPTION OF THE WORK SO FAR

This part-project started i February 1991 by signing the contract with NI. The work performed has comprised both experiments and market studies, preliminary technical design for pilot scale equipment, treatment capacity calculations, operational cost estimates. In the beginning of the project large effort was laid down in an attempt to get opportunities to build a pilot scale plant on line in an effluent stream. This attempt has, however, not yet worked out successfully, mostly due to lack of test results on their particular problem effluents. We have therefore concentrated on providing as good test results as possible, and will also concentrate on that in the rest of the project period.

The project is about midway with respect to performance, some of the test results we have not yet been allowed to publish. Therefore this report will have a preliminary form, both with repsect to content and apparence.

THE ELECTRON BEAM FACILITY

Electron beam treatment was performed by a Scanditronix EB 10 linear accelerator situated at Beta Tech in Jønkjøping, Sweden. An outline of the system is given in Fig. 1.

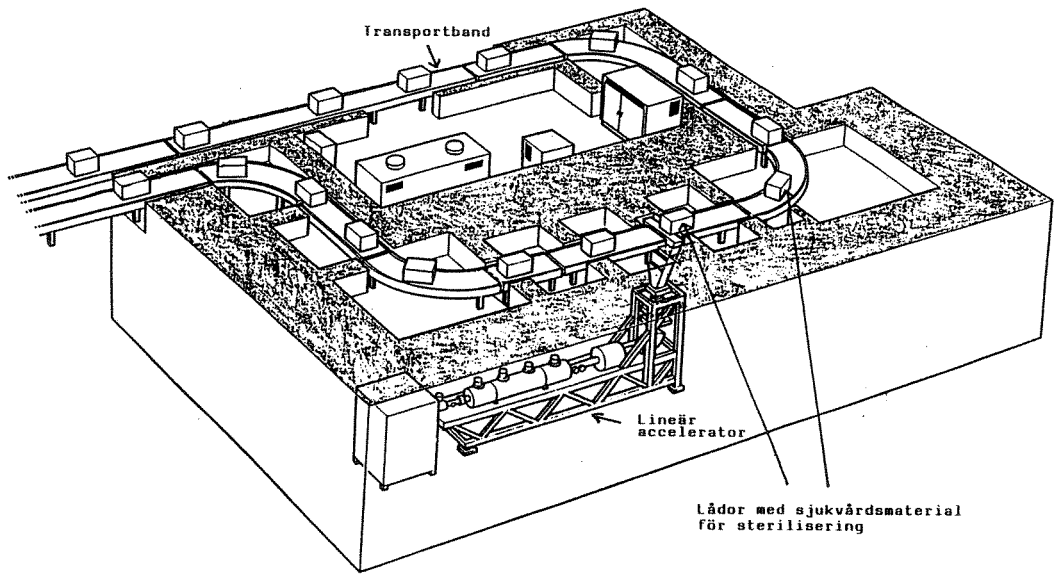


Fig.1 Outline of the Scanditronix EB 10 electron beam irradiation system at Beta Tech, Jønkjøping, Sweden.

The electron energy is 10 MeV (10 million Volts), whereas maximum beam power is 30 kW. The scanning width is 80 cm. The goods to be irradiated are moving on a conveyor belt and irradiated by parallel electron beams from below through a slit in the belt. Continuous active power to be supplied by the electrical power distribution unit to run the system is 260 kW.

The doses are automatically regulated by the speed of the conveyor belt by line-code labeling the goods.

The electrons from the machine can effectively penetrate approximately 3.5 cm of materials with density of water.

ELECTRON BEAM TREATMENT OF SLUDGE CONTAINING FULL CHLORINATED BENZENES

The full chlorinated benzenes are the most hazardious environmental toxins produced by industrial activities. Hitherto, incineration at high temperatures is recognized as the only way of degrading these compounds.

In our experiments, an industrial sludge from a magnesium factory (Norsk Hydro) containing serious environmental toxins as hexachlorobenzene, pentachlorobenzene, octachlorostyrene, decachlorobiphenyl, dibenzofurane, dioxine, etc. were given different doses of accelerated electrons varying from 5-50 kGy. Electron treatment were given under acidic, neutral and alkaline conditions, with and without small additions of hydrogen peroxide. The results are not fully evaluated, but it could be concluded that the direct EB-destruction is small, maximum 10-15%. At this stage we have not been allowed to publish the data. It is not yet decided wether we will continue with measurements of biodegradability of these compounds

or not, as the direct effect was so slight.

ELECTRON BEAMS ON KRAFT BLEACH EFFLUENTS

Treatments

Kraft Bleach effluent provided by KCL was sent from Finland by courier (TNT Express) and arrived NIVA the day after sampling. The sample was stored cool (4°C) for two more days before processing. The samples from Stora were picked up on the way to the irradiation facility in Jønkjøping and were processed the day after sampling. The pretreatment of the samples was performed at Beta Tech in Jønkjøping. The reference sample was handled in exactly the same way as the other samples except for any chemical treatment and irradiation.

Bleach kraft effluents from Stora A/B in Sweden and KCL in Finland were given doses of electron beams ranging from 10-50 kGy. Also here EB were given under acidic (Acidified by H_2SO_4 to pH about 2.5), neutral (untreated pH=7.3) , and alkaline (NaOH additions to about pH=11) conditions, with and without hydrogen peroxide, oxygen saturated and oxygen removed by N_2 bubbling. Table 1 shows the treatments of the different samples.

Table 1. EB doses and chemical pretreatment of the kraft bleach effluents from Stora AB and KCL.

Sample no.	Chemical Pretreatment	EB-dose kGy
1	Untreated reference	Not irradiated
2	Untreated	10
3	Untreated	50
4	Nitrogen bubbling for 20 minutes	10
5	Nitrogen bubbling for 20 minutes	50
6	Nitrogen bubbling for 20 minutes plus sulphuric acid to pH 2.5	10
7	Nitrogen bubbling for 20 minutes plus sulphuric acid to pH 2.5	50
8	Oxygen bubbling for 20 minutes	10
9	Oxygen bubbling for 20 minutes	50
10	Oxygen bubbling for 20 minutes plus NaOH to pH 11 plus H_2O_2	10
11	Oxygen bubbling for 20 minutes plus NaOH to pH 11 plus H_2O_2	50
12	Oxygen bubbling for 20 minutes plus NaOH to pH 11 plus H_2O_2	Not irradiated

Results

The results of the different treatments and direct radiochemical AOX removal from the samples from KCL are given in Fig.2 and Table 2.

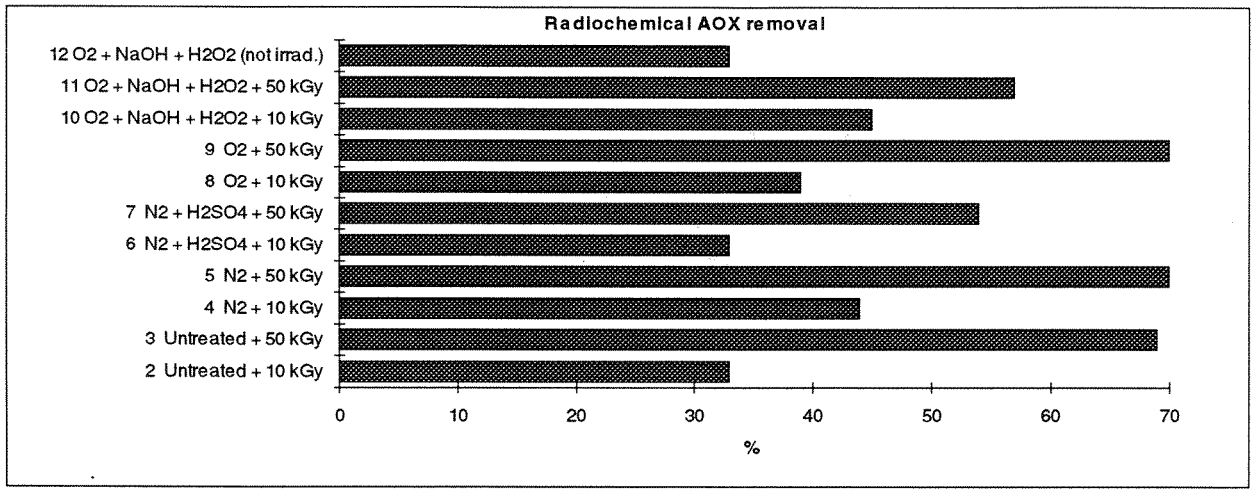


Fig.2 Radiochemical (EB=electron beam) AOX-removal from kraft bleach effluents from KCL, Finland.

Table 2. Radiochemical (electron beam) AOX removal from kraft bleach effluents from KCL, Finland.

Sample no.	Treatment Pretreatment and EB-dose	TOC mg/l	AOX mg/l	Percentage removal
1	Untreated reference	187	18	
2	Untreated + 10 kGy	225	12	33
3	Untreated + 50 kGy	234	5.7	69
4	N_2 + 10 kGy	210	10	44
5	N_2 + 50 kGy	243	5.4	70
6	N_2 + H_2SO_4 + 10 kGy	195	12	33
7	N_2 + H_2SO_4 + 50 kGy	196	8.3	54
8	O_2 + 10 kGy	202	11	39
9	O_2 + 50 kGy	207	5.4	70
10	O_2 + NaOH + H_2O_2 + 10 kGy	202	9.9	45
11	O_2 + NaOH + H_2O_2 + 50 kGy	182	7.7	57
12	O_2 + NaOH + H_2O_2	204	12	33

Unfortunately, the results from the Stora effluents are not yet permitted to be published, but the results were very similar to KCL samples, even somewhat better.

There was a clear correlation between the EB dose given and the degree of AOX removal. At low doses it also appeared that nitrogen bubbling and oxygen bubbling enhanced the AOX removal slightly. Additions of hydrogen peroxide gave reduced removal. The removal was highest at neutral conditions, and at high dose the removal was equally efficient in the not pretreated samples as the ones treated with oxygen and nitrogen. Thus, the pretreatment is not necessary at high EB doses.When considering all samples, both from Stora and KCL, the rough overall radiochemical removal was as follows:

10 kGy gave approximately 40% AOX removal
50 kGy " 70% "

The effect on TOC was negligible, indicating that a dechlorination takes place rather than a decomposition.

BIOLOGICAL AFTERTREATMENT OF THE SAMPLES

Methodology

The main idea behind the RadioBio-process was that the biodegradability of the samples should be enhanced by the irradiation, so the remaining compounds should be easy to break down in a biological second treatment step.

To test the biodgradability, and the biodegradation potential, it was performed standardized 28 days biodegradation tests on all samples from the KCL effluent (Reference :ISO/DIS 9408: *Water Quality Evaluation in an aqueous medium of the ultimate biodegradability of organic compounds - Method by determining the oxygen demand in closed respirometer,* and OECD: "*Guideline for testing of chemicals, 301 manometric respirometry-"ready biodegradability*").

The seed decomposers (inoculum) was a mixture of microorganisms from a laboratory produced activated sludge (Husman unit) grown in OECD synthetic sewage and municipal effluents aerated for 2 days (Norwegian Standard NS4849). The suspension was spin dried (3000 g) twice and resuspended in BOD-nutrient solution, to ensure wash out of dissolved components. The nutrient solution was ISO/DIS 9408. Suspended matter of inoculum in test solution was 20 mg/l.

The samples was incubated for 28 days at 20°C in closed flasks with oxygen available in surplus to break down all the organic material present including the added seed decomposers. This implied a 1:5 dilution of the samples.

The flaskes had total volume of 512 ml, of which the test solution occupied 250 ml. The rest content was air (Fig.3). The incubation was stirred continuously, permitting gas exchange across the surface (oxygen in - and carbon dioxide out). The released CO_2 was absorbed in a base containing cup. In this way the pressure fall within the flasks was due to oxygen consumption.

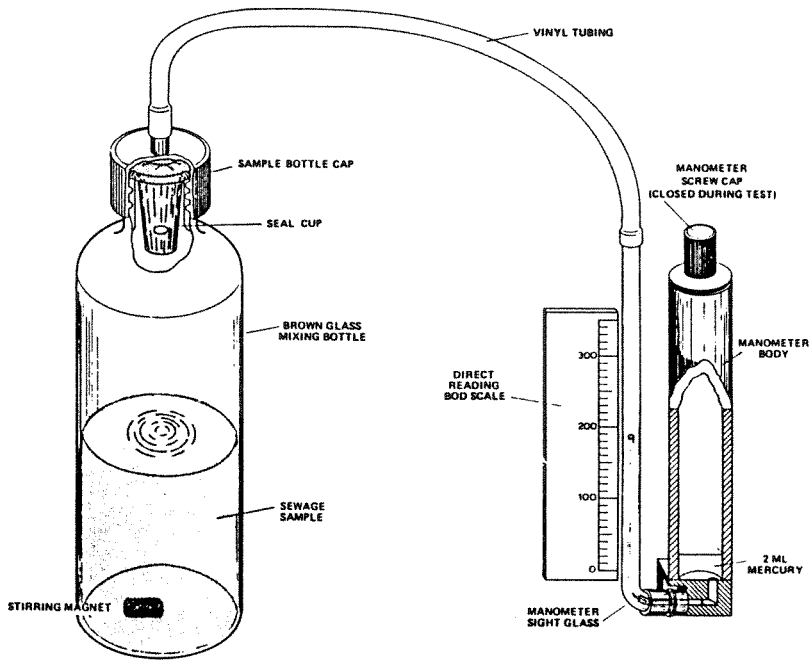


Fig.3 A schematic outline of the biodegradation test set-up (after the HACH manual).

Biological oxygen demand in the test solution was determined by oxygen analysis at the start and at the end of the experiment, and the course of the development determined by daily manometer readings (pressure fall).

The nitrate concentration was determined at the start and at the end of the experiment, to allow corrections for oxygen consumption by nitrification. The DOC and AOX of the samples were analysed at the start and at the end of the experiment.

Results

The results are interpreted as reduction of DOC, Oxygen consumption, and reduction of AOX during the biological degradation in Table 3 and Figs. 4-7.

Potential Toxicicity

The course of development both with regard to oxygen demand and DOC removal clearly showed that none of the samples acted toxic to the test organisms. If that had been the case, a lag phase would have appeared in the start of the experiments, see the oxygen curves (Fig.6).

Degradation of organic matter

Both the oxygen curves and the DOC removal should be inspected to evaluate what has taken place during the experiment, as DOC removal include both build up of decomposer biomass as well as CO_2 loss. Careful comparisons between the O_2 - curves and the DOC - removal,

realizing that it should be a certain proportion between O2-consumption and DOC-removal, indicates that the results are also somewhat confounded by leakage of DOC from the particulate phase. For these reasons the reduction in easily decomposable organic material (DOC) is a little difficult to evaluate.

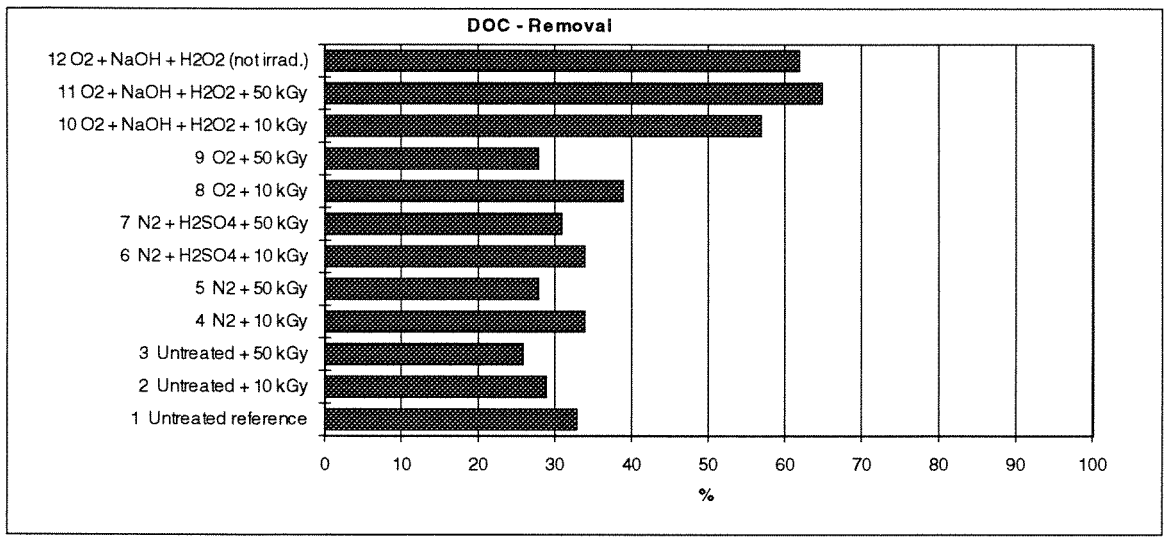


Fig.4 DOC-removal in 28 days degradation tests of the samples pretreated in different ways given at the left rim of the figure. The untreated reference is not irradiated, i.e. "pure effluent".

The DOC removal varies from 28% to 65% within the samples during the 28 days experiment, see Fig.4. The addition of H_2O_2 had the largest single factor effect on the DOC removal, with 62% in the not irradiated sample, 57% in the 10 kGy sample and 65% in the 50 kGy sample. As having only the start and end concentration of DOC, these values can not be said to be significantly different, despite the slightly higher degradation observed in the 50 kGy sample.

In the other treatments the DOC - removal varied around 30% (Fig.4). Compared to the reference sample, most of the 10 kGy irradiated samples indicated a slightly enhanced biodradability, while most of the 50 kGy irradiated samples seemed to reduce their degradability. It is not quite clear what causes these effects, the same has been discovered with respect to bioavailability of nutrients for algal growth after gamma and UV-irradiation of test water (Källqvist & Berge 1990, Gjessing & Källqvist 1991). The percentage depression was largest in the oxygen saturated sample, and least in the acidified oxygen free sample. This can indicate that the depression may be connected to formation of epoxides and peroxides (Lichtenthaler 1989).

Oxygen demand

The oxygen demand was measured daily during the experiment, and the curves are given in Fig.6, whereas the overall consumptions over the whole 28 days period are given in Fig.5.

The oxygen consumption should be a better parameter for comparing the biodegradability in the different samples as it is not confounded by the leakage of DOC from the particulate pool.

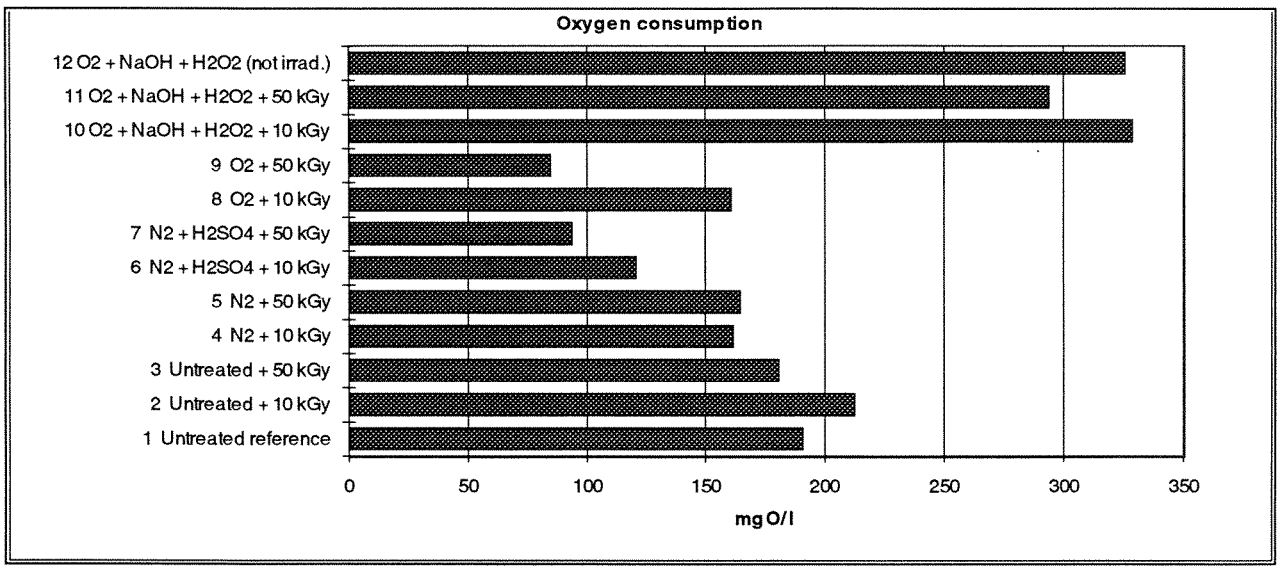


Fig.5 Overall oxygen consumption in 28 days degradation test of the samples pretreated in the way given at the left rim of the figure. The untreated reference is not irradiated, i.e. "pure effluent".

Both when inspecting the course of development curves (Fig.6) and the overall oxygen consumption (Fig.5) very much of the same pattern as was shown by DOC-removal, appears. The consumption was greatest in the samples pretreated with H_2O_2. Next highest O_2 consumption was measured in the not pretreated group of samples. Also here there is a clear tendency that the biodegradability is enhanced by 10 kGy EB-treatment, but depressed by the high dose of 50 kGy. The highest percentage depression was also here observed in the O_2 saturated sample, which strengthens the theory of oxygen singlets and triplets impeding the degradation.

The course of development curves (Fig.6) shows that the above stated differences started very early in the experiment and remained so throughout the whole test period, which indicate that the differences are significant, and not due to uncertainities in the analysis which is always a problem in this kind of experiments.

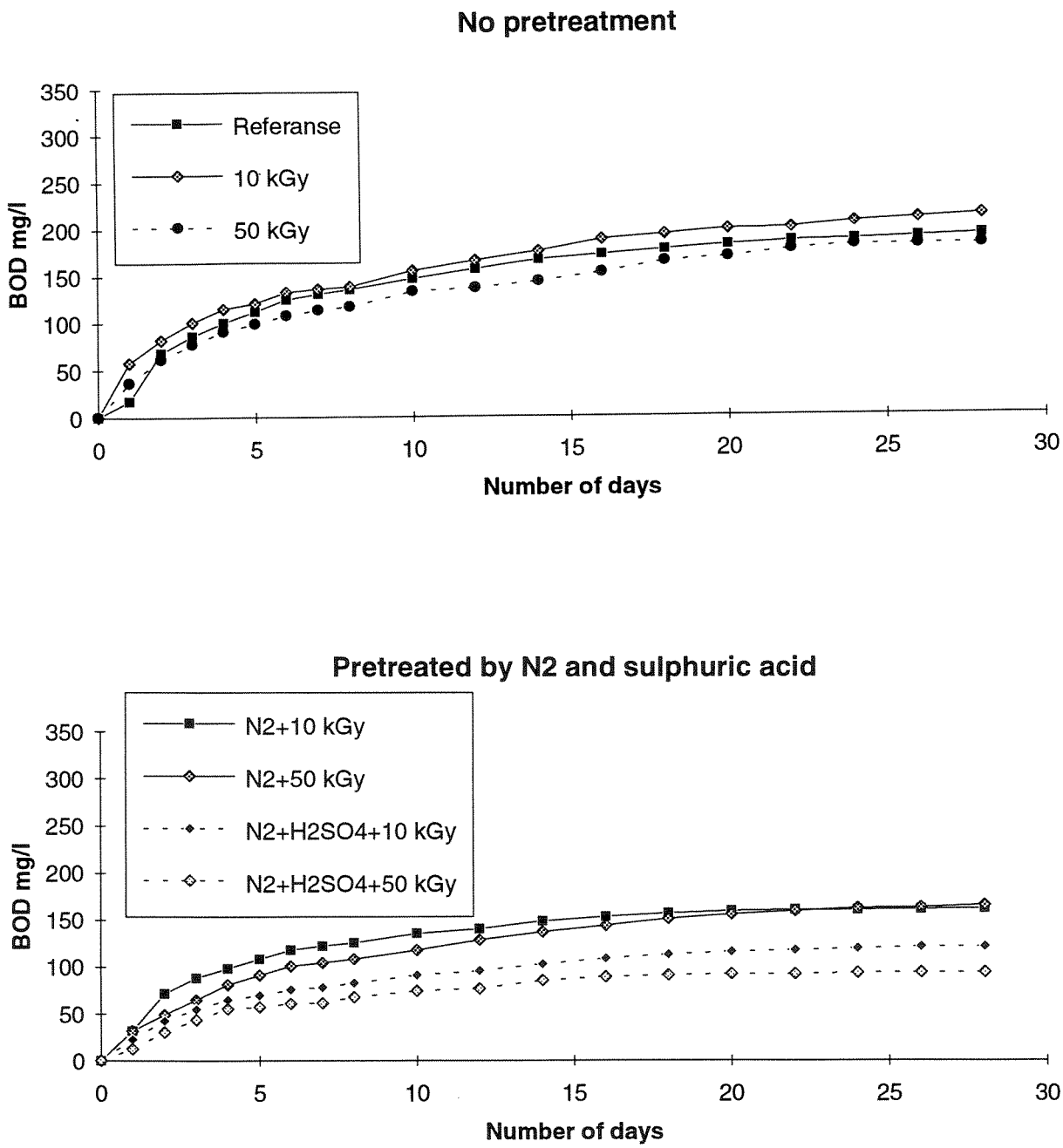
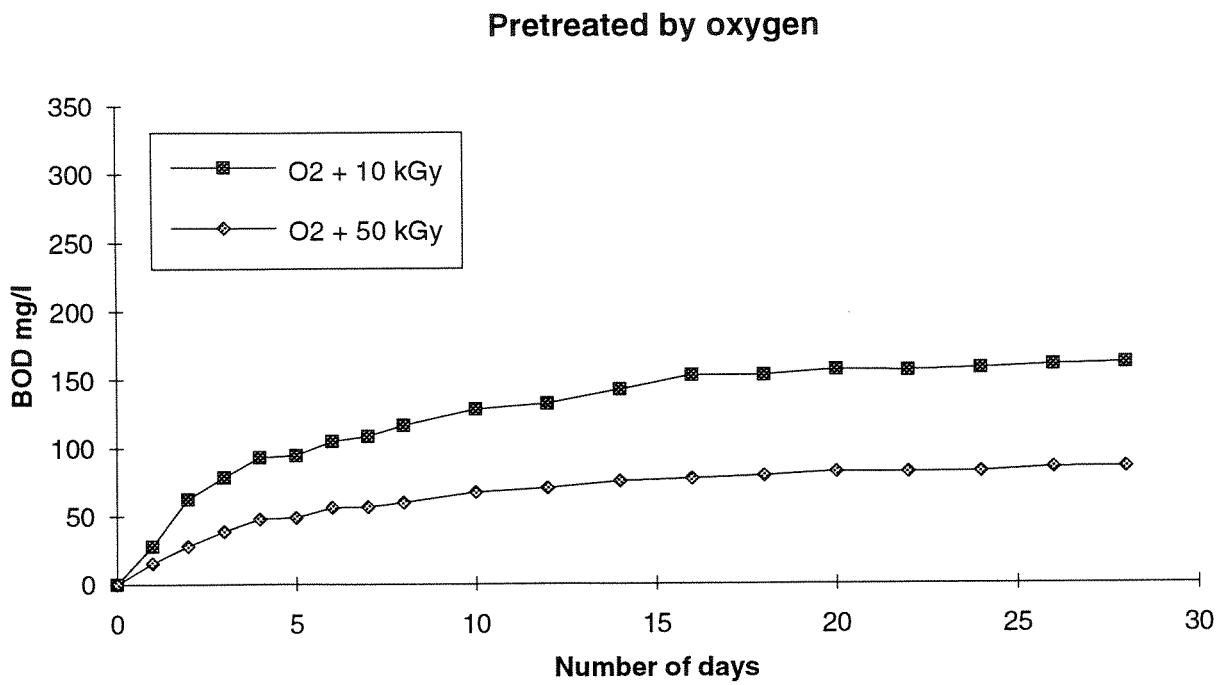


Fig.6 The lapse of oxygen consumption during the 28 days degradation test of the samples pretreated in the ways given in the legends of each plot. The untreated reference is not irradiated, i.e. "pure effluent".



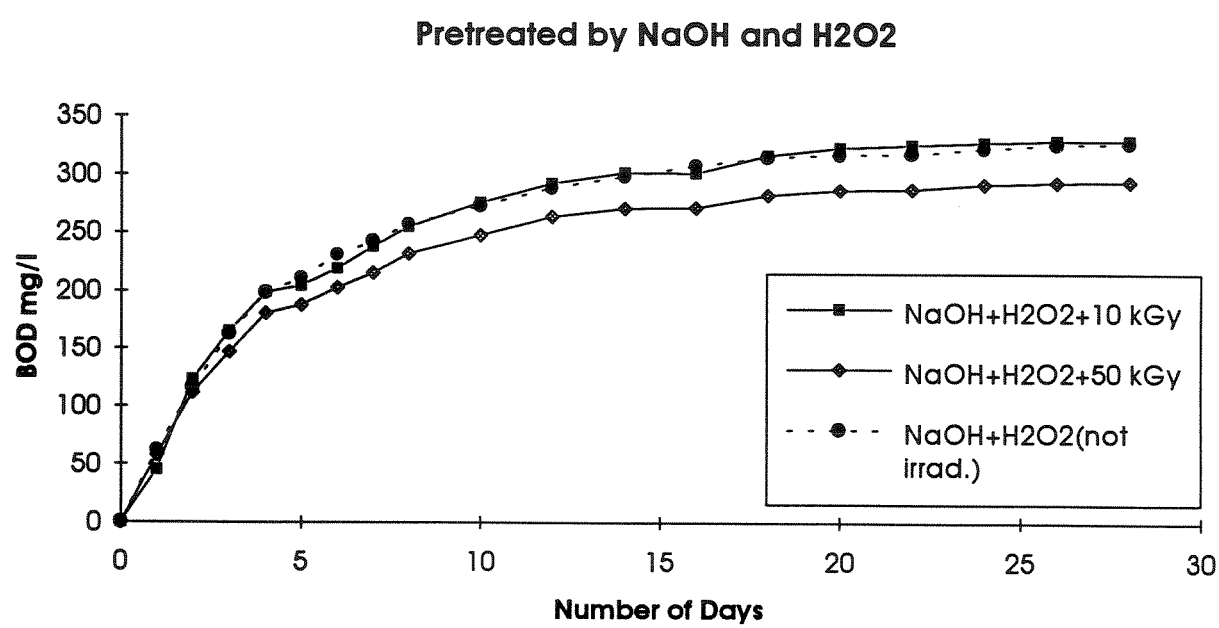


Fig.6 Cont. The lapse of oxygen consumption during the 28 days degradation test of the samples pretreated in the ways given in the legends of each plot. The untreated reference is not irradiated, i.e. "pure effluent".

Biodegradation AOX

The results from the biodegradation tests with respect to AOX-removal are given in Fig.7 and Table 3. The results in Fig.7 are given as percentage of what was available at the start of the biodeagradation test, which varied considerably between samples after the EB-irradiation.

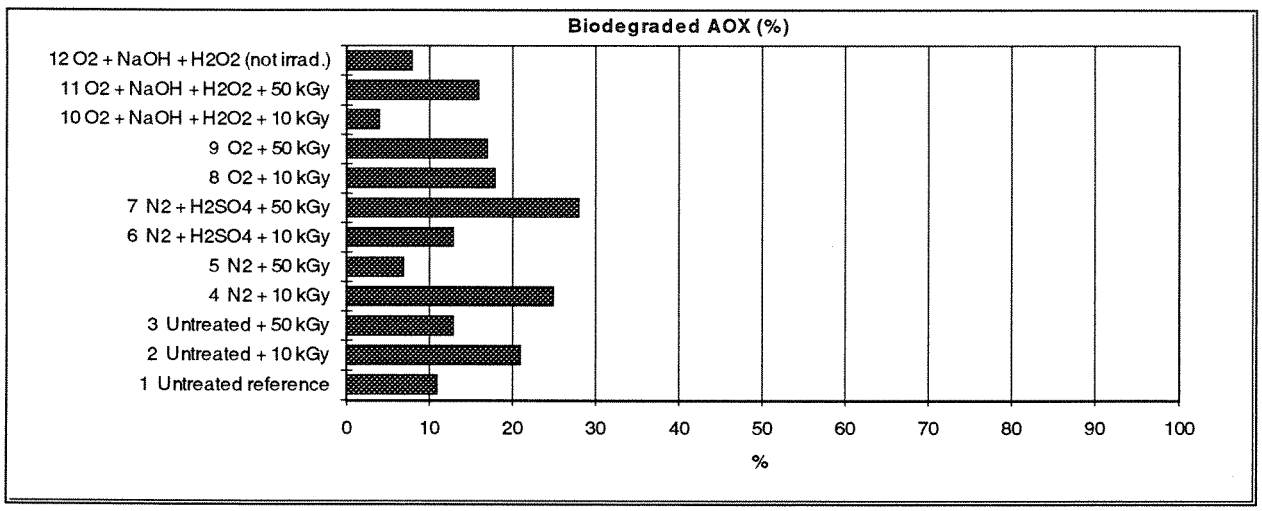


Fig.7 Biodegradation tests (28 days) of kraft bleach effluents with repect to AOX removal. The results are given as percent of the AOX available at the start of the experiment, which varied considerably in the different samples after the preceeding EB-degradation.

It is not easy to see any explanation for the unsystematic variation. The not irradiated reference had the forth lowest biodegradability among the 12 samples, which indicate there is an overall enhancement of the biodradability due to the electron beam treatment. It is, however, a little surprising that the samples pretreated by H_2O_2 which showed the highest biodegradability with respect to decomposing organic material, had of the smallest biodegradation of AOX.

On the other hand, the sample no. 7 which had the second lowest oxygen consumption, showed the highest biodegradation of AOX. Sample no. 2 and 4 had also high biodegradation of AOX. Common for these samples is that they have been irradiated under reductive conditions, anoxic, N_2 bubbling and acidified. It is known from the literature that the free solvated electrons are the most effective radiation products in dechlorination (JAERI 1988), and that they are partly neutralized if oxygen is present. This seems to be consistent also in these experiments. During the biodegradation oxygen was, however, present in all samples and further discussion on this at this stage will only be speculations.

Overall RadioBio degradation of AOX

In Fig.8 we have compiled the results on AOX removal with the combined treatment of radiochemical and biochemical oxidation of kraft bleach effluents, see also Table 3.

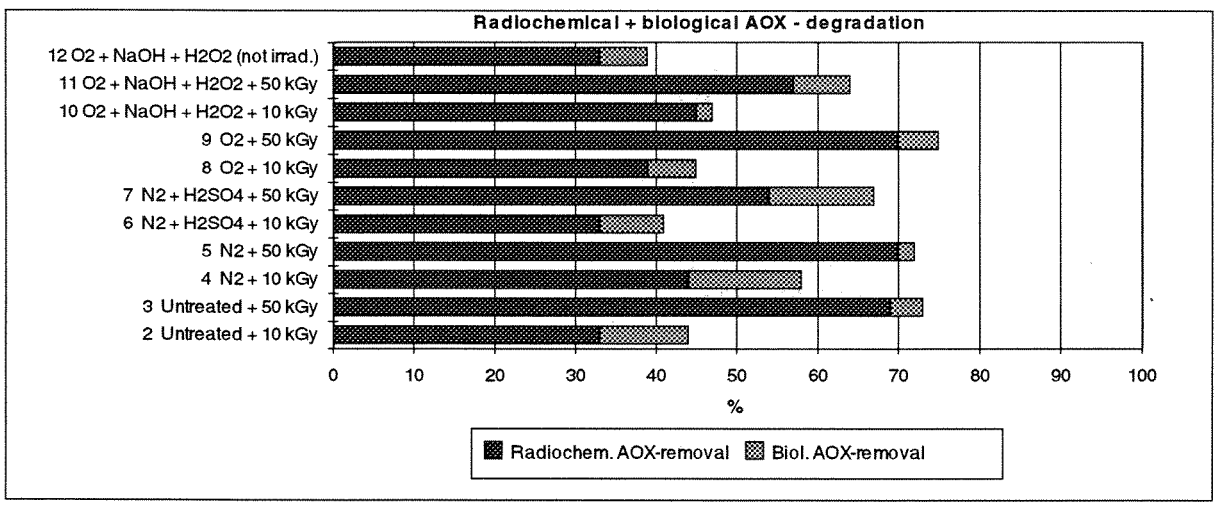


Fig.8 Overall RadioBio AOX - removals from the combined treatment of radiochemical and biochemical oxidation of kraft mill effluent from KCL, Finland.

Table 3 Overall effect of EB-treatment and biochemical oxidation i AOX removal in the kraft bleach effluent from KCL, Finland.

Sample no.	Treatment Pretreatment and EB-dose	AOX mg/l	Percentage radiochemical AOX-removal (%)	AOX after biodegra-dation mg/l	Percentage biodegraded AOX (% of start values in the biodegr.test)
1	Untreated reference	18		16	11
2	Untreated + 10 kGy	12	33	9.5	21
3	Untreated + 50 kGy	5.7	69	5	13
4	N_2 + 10 kGy	10	44	7.5	25
5	N_2 + 50 kGy	5.4	70	5	7
6	N_2 + H_2SO_4 + 10 kGy	12	33	10.5	13
7	N_2 + H_2SO_4 + 50 kGy	8.3	54	6	28
8	O_2 + 10 kGy	11	39	10	18
9	O_2 + 50 kGy	5.4	70	4.55	17
10	O_2 + NaOH + H_2O_2 + 10 kGy	9.9	45	9.5	4
11	O_2 + NaOH + H_2O_2 + 50 kGy	7.7	57	6.5	16
12	O_2 + NaOH + H_2O_2	12	33	11	8

It is obvious from the figure that the radiochemical treatment which lasted only a couple of seconds was much more efficient than the biological AOX-removal. The combined efficiency was about 75% removal, all observed in the highest EB-dose, in sample 3, 4 and 9. A highly oxidative environment, as in the alkaline H_2O_2 pretreated samples did not give the highest removal. There is some evidence that the materials were reductive at neutral pH since the O_2 bubbling (15 min) was not sufficient to saturate the sample, and these gave better AOX removals. As mentioned in the previous chapter on the EB-treatment, there was a clear connection between EB-dose and AOX-removal, and that it should be possible to increase radiochemical removal to about 90 percent, perhaps even greater.

ESTIMATED TREATMENT CAPACITY USING A SCANDITRONIX EB 10 MACHINE DIRECTLY ON THE EFFLUENT WATER.

Treatment capacity is often the limiting factor for introducing new effluent treatment technologies. In this section some preliminary treatment capacity estimates are presented confined with the machine applied in our tests, the Scanditronix EB 10 linear accelerator. This machine is at the moment the largest linear accelerator available for ordinary sale. However, it is possible to make them bigger. There are also other principles of accelerating electrons, which may give a larger treatment capacity, but for the time being it is relevant to use the EB 10 for capacity considerations.

As the life time of the reactive radicals formed during the irradiation is very short (pico-seconds), the dechlorination is most likely depending on a relatively close electron hit. The more AOX are removed, the more difficult it will be to get a close electron hit. Therefore we believe that the removal efficiency will level out as shown in Figure 9.

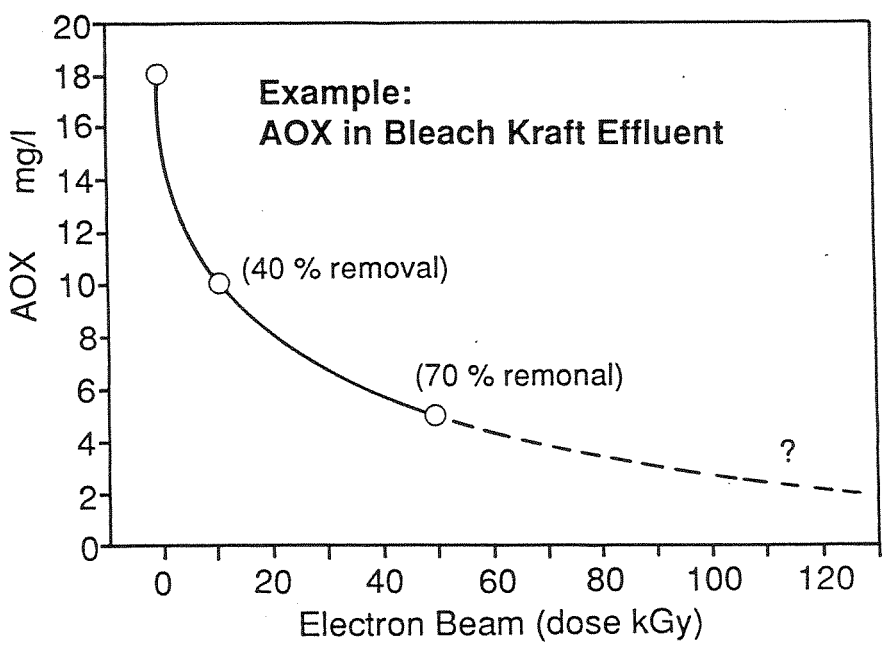


Fig.9 Average effect of electron beam treatment on AOX removal in kraft bleach effluent. The dotted line is the most likely extension of the EB-dose range included in the present study.

According to our findings the treatment capacities for 40%, 70% and 90% AOX removals are calculated approximately, and the results are given in Table 4.

Table 4. Treatment capacity for AOX removal in kraft bleach effluent with the Scanditronix EB 10.

AOX removal %	EB dose required kGy	Maximum treatment capacity (m3/hour)
40	10	108
70	50	22
90	120	9

In a typical bleach kraft effluent from a normal Scandinavian sized paper mill, the discharge is about 1500 m^3 /hour from the bleaching steps with an AOX concentration between 15-20 mg/l. These estimates indicate that the EB-treatment alone on the primary water phase effluent is impossible due to capacity problems.

Possible ways to overcome this capacity problem is to concentrate the AOX by chemical precipitation (from KCL) or membrane filtration (from IVL), and then treat the concentrate by the RadioBio process. This is what we are doing in the next phase of the Nordic coorporation.

In dealing with sludge we will also change the methods for testing the potential for degradation of the remaining by biological post-treatment. Some kind of composting and/or anaerobic fermentation are under consideration.

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APPENDIX - Primary analytical data

Table P1 Primary data on DOC-Removal

Test laboratorium: Norsk Institutt for Vannforskning, NIVA

O-91022 DOC.REDUKSJON %

KCL 1 Ubehandlet

Medium	Flaske	Startverdi	28 døgn
Inokulum	C1	2	3.17
"	C2	2	2.42
"	Cmv.	**2**	**2.80**
Teststoff.	A1	36.3	25.4
"	A2	36.3	26.3
"	Amv.	**36.30**	**25.85**
Korrigert startverdi		34.3	23.06
DOC-reduksjon etter x døgn nedbrytning			**33**

KCL-2 Ubehandlet + 10 kGy

Medium	Flaske	Startverdi	28 døgn
Inoculum	C1	2	3.17
"	C2	2	2.42
"	Cmv.	**2**	**2.80**
Teststoff.	A1	37.9	29.1
"	A2	37.9	27.7
"	Amv.	**37.90**	**28.40**
Korrigert startverdi		35.9	25.61
DOC-reduksjon etter x døgn nedbrytning			**29**

KCL-3 Ubehandlet+ 50 kGy

Medium	Flaske	Startverdi	28 døgn
Inoculum	C1	2	3.17
"	C2	2	2.42
"	Cmv.	**2**	**2.80**
Teststoff.	A1	39.2	29.7
"	A2	39.2	30.7
"	Amv.	**39.20**	**30.20**
Korrigert startverdi		37.2	27.41
DOC-reduksjon etter x døgn nedbrytning			**26**

KCL-4 N2 + 10 kGy

Medium	Flaske	Startverdi	28 døgn
Inoculum	C1	2	3.17
"	C2	2	2.42
"	Cmv.	**2**	**2.80**
Teststoff.	A1	38.3	25.6
"	A2	38.3	27.8
"	Amv.	**38.30**	**26.70**
Korrigert startverdi		36.3	23.91
DOC-reduksjon etter x døgn nedbrytning			**34**

Table P1 Primary data on DOC-Removal

KCL-5 N2 +50 kGy

Medium	Flaske	Startverdi	28 døgn
Inoculum	C1	2	3.17
"	C2	2	2.42
"	Cmv.	**2**	**2.80**
Teststoff.	A1	39.4	29.5
"	A2	39.4	30.1
"	Amv.	**39.40**	**29.80**
Korrigert startverdi		37.4	27.01
DOC-reduksjon etter x døgn nedbrytning			**28**

KCL-6 N2 +~~H2O2~~ H_2SO_4 + 10 kGy

Medium	Flaske	Startverdi	28 døgn
Inoculum	C1	2	3.17
"	C2	2	2.42
"	Cmv.	**2**	**2.80**
Teststoff.	A1	35.5	24.9
"	A2	35.5	24.7
"	Amv.	**35.50**	**24.80**
Korrigert startverdi		33.5	22.01
DOC-reduksjon etter x døgn nedbrytning			**34**

KCL-7 N2 +~~H2O2~~ H_2SO_4 + 50 kGy

Medium	Flaske	Startverdi	28 døgn
Inoculum	C1	2	3.17
"	C2	2	2.42
"	Cmv.	**2**	**2.80**
Teststoff.	A1	34.2	25.5
"	A2	34.2	24.5
"	Amv.	**34.20**	**25.00**
Korrigert startverdi		32.2	22.21
DOC-reduksjon etter x døgn nedbrytning			**31**

KCL-8 O2 + 10 kGy

Medium	Flaske	Startverdi	28 døgn
Inoculum	C1	2	3.17
"	C2	2	2.42
"	Cmv.	**2**	**2.80**
Teststoff.	A1	37.7	25
"	A2	37.7	24.5
"	Amv.	**37.70**	**24.75**
Korrigert startverdi		35.7	21.96
DOC-reduksjon etter x døgn nedbrytning			**39**

Table P1 Primary data on DOC-Removal

KCL-9 O2 + 50 kGy

Medium	Flaske	Startverdi	28 døgn
Inoculum	C1	2	3.17
"	C2	2	2.42
"	Cmv.	**2**	**2.80**
Teststoff.	A1	36.9	28
"	A2	36.9	27.6
"	Amv.	**36.90**	**27.80**
Korrigert startverdi		34.9	25.01
DOC-reduksjon etter x døgn nedbrytning			**28**

KCL-10 O2 + NaOH + H2O2 + 10 kGy

Medium	Flaske	Startverdi	28 døgn
Inoculum	C1	2	3.17
"	C2	2	2.42
"	Cmv.	**2**	**2.80**
Teststoff.	A1	34.6	17.5
"	A2	34.6	16.4
"	Amv.	**34.60**	**16.95**
Korrigert startverdi		32.6	14.16
DOC-reduksjon etter x døgn nedbrytning			**57**

KCL-11 O2 + NaOH + H2O2 + 50 kGy

Medium	Flaske	Startverdi	28 døgn
Inoculum	C1	2	3.17
"	C2	2	2.42
"	Cmv.	**2**	**2.80**
Teststoff.	A1	33.2	14.4
"	A2	33.2	12.8
"	Amv.	**33.20**	**13.60**
Korrigert startverdi		31.2	10.81
DOC-reduksjon etter x døgn nedbrytning			**65**

KCL-12 O2 + NaOH + H2O2 (ubestrålt)

Medium	Flaske	Startverdi	28 døgn
Inoculum	C1	2	3.17
"	C2	2	2.42
"	Cmv.	**2**	**2.80**
Teststoff.	A1	36.2	15.1
"	A2	36.2	16.3
"	Amv.	**36.20**	**15.70**
Korrigert startverdi		34.2	12.91
DOC-reduksjon etter x døgn nedbrytning			**62**

Table P2 Primary data on oxygen consumption

	KCl 1REFERANSE						BOD Snitt	BOD-sn.	BOD
Tid fra	Inoculum	Korr.inoc.	Rep.I	Korr.I	Rep.II	Korr.II	Kor.I-II	inoc. kor	*fort.fakt
start		0,56818		3,24576		2,974359			5
0	0	0,00	0	0	0	0	0,00	0,00	0
1	3,1	1,76	1,7	5,52	1,7	5,06	5,29	3,53	18
2	5,2	2,95	5,3	17,20	5,4	16,06	16,63	13,68	68
3	6,15	3,49	6,6	21,42	6,8	20,23	20,82	17,33	87
4	7,05	4,01	7,3	23,69	8,2	24,39	24,04	20,04	100
5	7,75	4,40	8,5	27,59	8,7	25,88	26,73	22,33	112
6	8,5	4,83	9,4	30,51	9,8	29,15	29,83	25,00	125
7	8,9	5,06	9,8	31,81	10,3	30,64	31,22	26,17	131
8	9,05	5,14	10,1	32,78	10,7	31,83	32,30	27,16	136
10	9,85	5,60	11,1	36,03	11,4	33,91	34,97	29,37	147
12	10,55	5,99	11,8	38,30	12,2	36,29	37,29	31,30	156
14	11,2	6,36	12,5	40,57	13	38,67	39,62	33,26	166
16	11,6	6,59	13	42,19	13,4	39,86	41,03	34,43	172
18	12,2	6,93	13,4	43,49	13,8	41,05	42,27	35,34	177
20	12,65	7,19	13,8	44,79	14,2	42,24	43,51	36,33	182
22	12,85	7,30	14	45,44	14,5	43,13	44,28	36,98	185
24	13,1	7,44	14	45,44	14,8	44,02	44,73	37,29	186
26	13,15	7,47	14,2	46,09	14,9	44,32	45,20	37,73	189
28	13,2	7,50	14,4	46,74	15	44,62	45,68	38,18	191

Table P2 Primary data on oxygen consumption

	KCl 2Ubeh. + 10 kGy								
Tid fra	Inoculum	Korr.inoc.	Rep.I	Korr.I	Rep.II	Korr.II	BOD Snittv	BOD-sn.	BOD
start		0,56818		3,84058		3,587786	Kor.I-II	inoc. kor	*fort.fakt
0	0	0,00	0	0	0	0	0,00	0,00	5
1	3,1	1,76	4,8	18,43	2,3	8,25	13,34	11,58	58
2	5,2	2,95	5,8	22,28	4,6	16,50	19,39	16,44	82
3	6,15	3,49	7	26,88	5,7	20,45	23,67	20,17	101
4	7,05	4,01	7,8	29,96	6,7	24,04	27,00	22,99	115
5	7,75	4,40	7,8	29,96	7,6	27,27	28,61	24,21	121
6	8,5	4,83	8,6	33,03	8,3	29,78	31,40	26,57	133
7	8,9	5,06	8,8	33,80	8,6	30,85	32,33	27,27	136
8	9,05	5,14	9	34,57	8,7	31,21	32,89	27,75	139
10	9,85	5,60	10	38,41	9,7	34,80	36,60	31,01	155
12	10,55	5,99	10,7	41,09	10,3	36,95	39,02	33,03	165
14	11,2	6,36	11,2	43,01	11,1	39,82	41,42	35,06	175
16	11,6	6,59	12	46,09	11,8	42,34	44,21	37,62	188
18	12,2	6,93	12,4	47,62	12,1	43,41	45,52	38,59	193
20	12,65	7,19	12,9	49,54	12,3	44,13	46,84	39,65	198
22	12,85	7,30	13	49,93	12,4	44,49	47,21	39,91	200
24	13,1	7,44	13,4	51,46	12,7	45,56	48,51	41,07	205
26	13,15	7,47	13,6	52,23	12,9	46,28	49,26	41,79	209
28	13,2	7,50	13,8	53,00	13,1	47,00	50,00	42,50	213

Table P2 Primary data on oxygen consumption

	KCl 3Ubeh. + 50 kGy						BOD Snittv	BOD-sn.	BOD
Tid fra	Inoculum	Korr.inoc.	Rep.I	Korr.I	Rep.II	Korr.II	Kor.I-II	inoc. kor	*fort.fakt
start		0,56818		3,84058		3,587786			5
0	0	0,00	0	0	0	0	0,00	0,00	0
1	3,1	1,76	2,5	9,60	2,4	8,61	9,11	7,34	37
2	5,2	2,95	4,1	15,75	4,1	14,71	15,23	12,27	61
3	6,15	3,49	5,1	19,59	5,1	18,30	18,94	15,45	77
4	7,05	4,01	5,9	22,66	6	21,53	22,09	18,09	90
5	7,75	4,40	6,3	24,20	6,7	24,04	24,12	19,71	99
6	8,5	4,83	7,2	27,65	7	25,11	26,38	21,55	108
7	8,9	5,06	7,3	28,04	7,7	27,63	27,83	22,77	114
8	9,05	5,14	7,4	28,42	8	28,70	28,56	23,42	117
10	9,85	5,60	8,7	33,41	8,7	31,21	32,31	26,72	134
12	10,55	5,99	8,9	34,18	9	32,29	33,24	27,24	136
14	11,2	6,36	9,1	34,95	9,8	35,16	35,05	28,69	143
16	11,6	6,59	10	38,41	10	35,88	37,14	30,55	153
18	12,2	6,93	10,7	41,09	10,7	38,39	39,74	32,81	164
20	12,65	7,19	10,9	41,86	11,1	39,82	40,84	33,66	168
22	12,85	7,30	11,7	44,93	11,2	40,18	42,56	35,26	176
24	13,1	7,44	11,8	45,32	11,6	41,62	43,47	36,03	180
26	13,15	7,47	11,8	45,32	11,6	41,62	43,47	36,00	180
28	13,2	7,50	11,8	45,32	11,7	41,98	43,65	36,15	181

Table P2 Primary data on oxygen consumption

	KCl 4 N2 + 10 kGy						BOD Snittv	BOD-sn.	BOD
Tid fra	Inoculum	Korr.inoc.	Rep.I	Korr.I	Rep.II	Korr.II	Kor.I-II	inoc. kor	*fort.fakt
start		0,56818		3,5462963		3,37398			5
0	0	0,00	0	0	0	0	0,00	0,00	0
1	3,1	1,76	2,1	7,45	2,6	8,77	8,11	6,35	32
2	5,2	2,95	4,8	17,02	5,2	17,54	17,28	14,33	72
3	6,15	3,49	5,8	20,57	6,4	21,59	21,08	17,59	88
4	7,05	4,01	6,7	23,76	7	23,62	23,69	19,68	98
5	7,75	4,40	7,4	26,24	7,7	25,98	26,11	21,71	109
6	8,5	4,83	8,2	29,08	8,2	27,67	28,37	23,54	118
7	8,9	5,06	8,4	29,79	8,6	29,02	29,40	24,35	122
8	9,05	5,14	8,6	30,50	8,9	30,03	30,26	25,12	126
10	9,85	5,60	9,3	32,98	9,6	32,39	32,69	27,09	135
12	10,55	5,99	9,6	34,04	10,1	34,08	34,06	28,07	140
14	11,2	6,36	10,3	36,53	10,6	35,76	36,15	29,78	149
16	11,6	6,59	10,5	37,24	11,1	37,45	37,34	30,75	154
18	12,2	6,93	10,7	37,95	11,5	38,80	38,37	31,44	157
20	12,65	7,19	10,7	37,95	11,9	40,15	39,05	31,86	159
22	12,85	7,30	10,7	37,95	12,1	40,83	39,39	32,08	160
24	13,1	7,44	10,7	37,95	12,2	41,16	39,55	32,11	161
26	13,15	7,47	10,7	37,95	12,3	41,50	39,72	32,25	161
28	13,2	7,50	10,8	38,30	12,3	41,50	39,90	32,40	162

Table P2 Primary data on oxygen consumption

	KCl 5 N2 + 50 kGy								
Tid fra	Inoculum	Korr.inoc.	Rep.I	Korr.I	Rep.II	Korr.II	BOD Snitt	BOD-sn.	BOD
start		0,56818		3,19685		3,27419	Kor.I-II	inoc. kor	*fort.fakt
0	0	0,00	0	0	0	0			5
1	3,1	1,76	2,6	8,31	2,4	7,86	0,00	0,00	0
2	5,2	2,95	4,1	13,11	3,8	12,44	8,08	6,32	32
3	6,15	3,49	5,2	16,62	5	16,37	12,77	9,82	49
4	7,05	4,01	6,2	19,82	6,3	20,63	16,50	13,00	65
5	7,75	4,40	7	22,38	7	22,92	20,22	16,22	81
6	8,5	4,83	7,7	24,62	7,7	25,21	22,65	18,25	91
7	8,9	5,06	7,8	24,94	8,2	26,85	24,91	20,08	100
8	9,05	5,14	8,3	26,53	8,3	27,18	25,89	20,84	104
10	9,85	5,60	9	28,77	9	29,47	26,85	21,71	109
12	10,55	5,99	9,8	31,33	9,8	32,09	29,12	23,52	118
14	11,2	6,36	10,4	33,25	10,5	34,38	31,71	25,71	129
16	11,6	6,59	10,9	34,85	11	36,02	33,81	27,45	137
18	12,2	6,93	11,5	36,76	11,5	37,65	35,43	28,84	144
20	12,65	7,19	12	38,36	11,7	38,31	37,21	30,28	151
22	12,85	7,30	12,3	39,32	11,9	38,96	38,34	31,15	156
24	13,1	7,44	12,6	40,28	12,1	39,62	39,14	31,84	159
26	13,15	7,47	12,6	40,28	12,2	39,95	39,95	32,51	163
28	13,2	7,50	12,7	40,60	12,4	40,60	40,11	32,64	163
							40,60	33,10	165

Table P2 Primary data on oxygen consumption

	KCl 6 N2 +H2SO4+ 10 kGy						BOD Snitt	BOD-sn.	BOD
Tid fra	Inoculum	Korr.inoc.	Rep.I	Korr.I	Rep.II	Korr.II	Kor.I-II	inoc. kor	*fort.fakt
start		0,56818		2,619		2,467742			5
0	0	0,00	0	0	0	0	0,00	0,00	0
1	3,1	1,76	2,6	6,81	2,4	5,92	6,37	4,60	23
2	5,2	2,95	4,1	10,74	4,9	12,09	11,41	8,46	42
3	6,15	3,49	5,2	13,62	6,2	15,30	14,46	10,97	55
4	7,05	4,01	6,2	16,24	7,2	17,77	17,00	13,00	65
5	7,75	4,40	7	18,33	7,4	18,26	18,30	13,89	69
6	8,5	4,83	7,7	20,17	8	19,74	19,95	15,12	76
7	8,9	5,06	7,8	20,43	8,5	20,98	20,70	15,65	78
8	9,05	5,14	8,3	21,74	8,8	21,72	21,73	16,58	83
10	9,85	5,60	9	23,57	9,7	23,94	23,75	18,16	91
12	10,55	5,99	9,8	25,67	10	24,68	25,17	19,18	96
14	11,2	6,36	10,4	27,24	10,8	26,65	26,94	20,58	103
16	11,6	6,59	10,9	28,55	11,4	28,13	28,34	21,75	109
18	12,2	6,93	11,5	30,12	11,7	28,87	29,50	22,56	113
20	12,65	7,19	12	31,43	11,9	29,37	30,40	23,21	116
22	12,85	7,30	12,3	32,21	12	29,61	30,91	23,61	118
24	13,1	7,44	12,4	32,48	12,3	30,35	31,41	23,97	120
26	13,15	7,47	12,6	33,00	12,4	30,60	31,80	24,33	122
28	13,2	7,50	12,6	33,00	12,4	30,60	31,80	24,30	121

Table P2 Primary data on oxygen consumption

	KCl 7 N2 +H2SO4+ 50 kGy								
Tid fra	Inoculum	Korr.inoc.	Rep.I	Korr.I	Rep.II	Korr.II	BOD Snitt	BOD-sn.	BOD
start		0,56818		2,40187		2,4907	Kor.I-II	inoc. kor	*fort.fakt
0	0	0,00	0	0	0	0			5
1	3,1	1,76	1,7	4,08	1,8	4,48	0,00	0,00	0
2	5,2	2,95	3,6	8,65	3,8	9,46	4,28	2,52	13
3	6,15	3,49	5	12,01	5	12,45	9,06	6,10	31
4	7,05	4,01	6,3	15,13	6	14,94	12,23	8,74	44
5	7,75	4,40	6,6	15,85	6,4	15,94	15,04	11,03	55
6	8,5	4,83	7	16,81	6,9	17,19	15,90	11,49	57
7	8,9	5,06	7	16,81	7,2	17,93	17,00	12,17	61
8	9,05	5,14	7,6	18,25	7,7	19,18	17,37	12,32	62
10	9,85	5,60	8,4	20,18	8,4	20,92	18,72	13,57	68
12	10,55	5,99	8,7	20,90	8,8	21,92	20,55	14,95	75
14	11,2	6,36	9,7	23,30	9,5	23,66	21,41	15,41	77
16	11,6	6,59	10	24,02	10	24,91	23,48	17,12	86
18	12,2	6,93	10,3	24,74	10,3	25,65	24,46	17,87	89
20	12,65	7,19	10,4	24,98	10,6	26,40	25,20	18,26	91
22	12,85	7,30	10,5	25,22	10,6	26,40	25,69	18,50	93
24	13,1	7,44	10,7	25,70	10,7	26,65	25,81	18,51	93
26	13,15	7,47	10,7	25,70	10,8	26,90	26,18	18,73	94
28	13,2	7,50	10,7	25,70	10,8	26,90	26,30	18,83	94
							26,30	18,80	94

Table P2 Primary data on oxygen consumption

	KCl 8 O2 + 10 kGy						BOD Snittv	BOD-sn.	BOD
Tid fra	Inoculum	Korr.inoc.	Rep.I	Korr.I	Rep.II	Korr.II	Kor.I-II	inoc. kor	*fort.fakt
start		0,56818		3,3865546		3,1788618			5
0	0	0,00	0	0	0	0	0,00	0,00	0
1	3,1	1,76	2,1	7,11	2,4	7,63	7,37	5,61	28
2	5,2	2,95	4,7	15,92	4,7	14,94	15,43	12,47	62
3	6,15	3,49	5,7	19,30	6	19,07	19,19	15,69	78
4	7,05	4,01	6,7	22,69	7,1	22,57	22,63	18,62	93
5	7,75	4,40	7	23,71	7,2	22,89	23,30	18,89	94
6	8,5	4,83	7,7	26,08	8	25,43	25,75	20,92	105
7	8,9	5,06	8	27,09	8,3	26,38	26,74	21,68	108
8	9,05	5,14	8,6	29,12	8,7	27,66	28,39	23,25	116
10	9,85	5,60	9,4	31,83	9,6	30,52	31,18	25,58	128
12	10,55	5,99	10	33,87	9,7	30,83	32,35	26,36	132
14	11,2	6,36	10,6	35,90	10,6	33,70	34,80	28,43	142
16	11,6	6,59	11,6	39,28	11	34,97	37,13	30,53	153
18	12,2	6,93	11,4	38,61	11,4	36,24	37,42	30,49	152
20	12,65	7,19	11,6	39,28	11,8	37,51	38,40	31,21	156
22	12,85	7,30	11,6	39,28	11,8	37,51	38,40	31,10	155
24	13,1	7,44	11,7	39,62	12	38,15	38,88	31,44	157
26	13,15	7,47	11,8	39,96	12,2	38,78	39,37	31,90	160
28	13,2	7,50	11,9	40,30	12,3	39,10	39,70	32,20	161

Table P2 Primary data on oxygen consumption

	KCl 9 O2 + 50 kGy								
Tid fra	Inoculum	Korr.inoc.	Rep.I	Korr.I	Rep.II	Korr.II	BOD Snitt	BOD-sn.	BOD
start		0,56818		2,64706		2,1359	Kor.I-II	inoc. kor	*fort.fakt
0	0	0,00	0	0	0	0			5
1	3,1	1,76	2	5,29	2	4,27	0,00	0,00	0
2	5,2	2,95	3,40	9,00	3,8	8,12	4,78	3,02	15
3	6,15	3,49	4,6	12,18	4,8	10,25	8,56	5,60	28
4	7,05	4,01	5,7	15,09	5,6	11,96	11,21	7,72	39
5	7,75	4,40	5,8	15,35	6	12,82	13,52	9,52	48
6	8,5	4,83	6,7	17,74	6,7	14,31	14,08	9,68	48
7	8,9	5,06	6,8	18,00	6,9	14,74	16,02	11,19	56
8	9,05	5,14	7	18,53	7,3	15,59	16,37	11,31	57
10	9,85	5,60	7,9	20,91	8	17,09	17,06	11,92	60
12	10,55	5,99	8,2	21,71	8,6	18,37	19,00	13,40	67
14	11,2	6,36	8,9	23,56	9	19,22	20,04	14,04	70
16	11,6	6,59	9,2	24,35	9,2	19,65	21,39	15,03	75
18	12,2	6,93	9,4	24,88	9,6	20,50	22,00	15,41	77
20	12,65	7,19	9,8	25,94	9,9	21,15	22,69	15,76	79
22	12,85	7,30	9,8	25,94	10	21,36	23,54	16,36	82
24	13,1	7,44	9,8	25,94	10,1	21,57	23,65	16,35	82
26	13,15	7,47	10,2	27,00	10,2	21,79	23,76	16,31	82
28	13,2	7,50	10,2	27,00	10,3	22,00	24,39	16,92	85
							24,50	17,00	85

Table P2 Primary data on oxygen consumption

	KCl 10 + NaOH + H2O2 + 10						BOD Snitt	BOD-sn.	BOD
Tid fra start	Inoculum	Korr.inoc.	Rep.I	Korr.I	Rep.II	Korr.II	Kor.I-II	inoc. kor	*fort.fakt
		0,56818		4,20349		3,715			5
0	0	0,00	0	0	0	0	0,00	0,00	0
1	3,1	1,76	2,3	9,67	3,2	11,89	10,78	9,02	45
2	5,2	2,95	6,80	28,58	7,2	26,75	27,67	24,71	124
3	6,15	3,49	8,8	36,99	9,7	36,04	36,51	33,02	165
4	7,05	4,01	10,8	45,40	11,3	41,98	43,69	39,68	198
5	7,75	4,40	11,2	47,08	11,7	43,47	45,27	40,87	204
6	8,5	4,83	12	50,44	12,6	46,81	48,63	43,80	219
7	8,9	5,06	12,8	53,80	13,8	51,27	52,54	47,48	237
8	9,05	5,14	13,8	58,01	14,6	54,24	56,12	50,98	255
10	9,85	5,60	14,9	62,63	15,8	58,70	60,66	55,07	275
12	10,55	5,99	15,6	65,57	17	63,16	64,36	58,37	292
14	11,2	6,36	16,1	67,68	17,7	65,76	66,72	60,35	302
16	11,6	6,59	16,1	67,68	17,7	65,76	66,72	60,12	301
18	12,2	6,93	16,7	70,20	18,9	70,21	70,21	63,27	316
20	12,65	7,19	17	71,46	19,4	72,07	71,77	64,58	323
22	12,85	7,30	17	71,46	19,7	73,19	72,32	65,02	325
24	13,1	7,44	17,2	72,30	19,8	73,56	72,93	65,49	327
26	13,15	7,47	17,2	72,30	20	74,30	73,30	65,83	329
28	13,2	7,50	17,2	72,30	20	74,30	73,30	65,80	329

Table P2 Primary data on oxygen consumption

	KCl 11 + NaOH + H2O2 + 50						BOD Snitt	BOD-sn.	BOD
Tid fra	Inoculum	Korr.inoc.	Rep.I	Korr.I	Rep.II	Korr.II	Kor.I-II	inoc. kor	*fort.fakt
start		0,56818		3,865168		3,37566			5
0	0	0,00	0	0	0	0	0,00	0,00	0
1	3,1	1,76	3,5	13,53	3,9	13,17	13,35	11,59	58
2	5,2	2,95	6,70	25,90	7,3	24,64	25,27	22,31	112
3	6,15	3,49	8,8	34,01	9,4	31,73	32,87	29,38	147
4	7,05	4,01	10,6	40,97	11,6	39,16	40,06	36,06	180
5	7,75	4,40	11,1	42,90	12,1	40,85	41,87	37,47	187
6	8,5	4,83	12	46,38	13,1	44,22	45,30	40,47	202
7	8,9	5,06	12,9	49,86	13,7	46,25	48,05	43,00	215
8	9,05	5,14	13,8	53,34	14,7	49,62	51,48	46,34	232
10	9,85	5,60	14,8	57,20	15,7	53,00	55,10	49,50	248
12	10,55	5,99	15,8	61,07	16,7	56,37	58,72	52,73	264
14	11,2	6,36	16,3	63,00	17,2	58,06	60,53	54,17	271
16	11,6	6,59	16,3	63,00	17,4	58,74	60,87	54,28	271
18	12,2	6,93	17,1	66,09	18	60,76	63,43	56,50	282
20	12,65	7,19	17,4	67,25	18,3	61,77	64,51	57,33	287
22	12,85	7,30	17,5	67,64	18,3	61,77	64,71	57,41	287
24	13,1	7,44	17,7	68,41	18,7	63,12	65,77	58,33	292
26	13,15	7,47	17,8	68,80	18,8	63,46	66,13	58,66	293
28	13,2	7,50	17,8	68,80	18,9	63,80	66,30	58,80	294

Table P2 Primary data on oxygen consumption

	KCl 12 + NaOH + H2O2						BOD Snitt	BOD-sn.	BOD
Tid fra	Inoculum	Korr.inoc.	Rep.I	Korr.I	Rep.II	Korr.II	Kor.I-II	inoc. kor	*fort.fakt
start		0,56818		3,448276		3,83756			5
0	0	0,00	0	0	0	0	0,00	0,00	0
1	3,1	1,76	4,6	15,86	3,3	12,66	14,26	12,50	63
2	5,2	2,95	7,70	26,55	6,7	25,71	26,13	23,18	116
3	6,15	3,49	10,4	35,86	9,4	36,07	35,97	32,47	162
4	7,05	4,01	12,5	43,10	11,5	44,13	43,62	39,61	198
5	7,75	4,40	13,3	45,86	12,3	47,20	46,53	42,13	211
6	8,5	4,83	14,4	49,66	13,6	52,19	50,92	46,09	230
7	8,9	5,06	15,2	52,41	14,2	54,49	53,45	48,40	242
8	9,05	5,14	16	55,17	15,1	57,95	56,56	51,42	257
10	9,85	5,60	17	58,62	16,1	61,78	60,20	54,61	273
12	10,55	5,99	18	62,07	17	65,24	63,65	57,66	288
14	11,2	6,36	18,6	64,14	17,7	67,92	66,03	59,67	298
16	11,6	6,59	19	65,52	18,4	70,61	68,06	61,47	307
18	12,2	6,93	19,6	67,59	18,8	72,15	69,87	62,93	315
20	12,65	7,19	19,8	68,28	19	72,91	70,59	63,41	317
22	12,85	7,30	19,9	68,62	19	72,91	70,77	63,47	317
24	13,1	7,44	20	68,97	19,5	74,83	71,90	64,46	322
26	13,15	7,47	20,2	69,66	19,7	75,60	72,63	65,16	326
28	13,2	7,50	20,3	70,00	19,7	75,60	72,80	65,30	326

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